

MARINE SAFETY MANUAL

- 3.G.1 g. (cont'd) the user of the official referenced standard. At times, that edition may not be the latest edition of the standard thus causing confusion within the industry. Since most standard changes often respond to an identified problem or hazard, and usually result in safer equipment, the USCG has allowed for equivalency determinations (46 CFR 110.20-1). In most instances, equipment constructed and tested in accordance with a more recent edition of a referenced document can be accepted as long as they provide a level of safety equivalent to that provided by equipment constructed and tested to the edition identified in the CFR.

2. Equipment.

- a. Systems Approach. The Electrical Engineering Regulations are a combination of equipment and system requirements designed to ensure that electrical installations are both safe and functional. They consist of general requirements related to across-the-board "good marine practice," and specific requirements related to the various apparatus, their proper design, installation and use.

In years past, emphasis was placed on equipment design requirements, as the system was considered the sum of the components (equipment). Today, equipment quality has generally improved and manufacturers have become more aware of product safety and liability. Comprehensive industry standards now exist and are used for most apparatus. This is allowing the review emphasis to shift towards a systems approach. As indicated previously, evaluations of equipment should consider overall safety comparability. With today's limited resources for plan review and inspection, concentration should be on proper application of equipment, effect of failures on required system functions, and on vital safety features.

Emphasis should be on evaluating the "system" -

Is the apparatus enclosure appropriate for the location?

Is the fixture adequately grounded to reduce the shock hazard? -

Is the fixture enclosure fire retardant and not surrounded by combustibles?

Will the first upstream overcurrent device safely clear a fault in the fixture so that other parts of the electrical system are not needlessly affected?

If it is a vital safety system, is the failure indicated and an alternative or back-up provided?

Do the components go together?

This is the "systems" approach. This does not imply that individual equipment design details are not important, but stresses that where there are limiting constraints, the system should be given a higher priority.

A recent casualty can be used to illustrate the necessity of "systems" thinking. While working on a motor controller, a crew

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- 3.G.2 a. (cont'd) member's screwdriver caused a short circuit. The upstream circuit breaker on the main board became damaged and did not open. Eventually, the generator circuit breaker tripped, but only after the switchboard had been destroyed, with the bus bars torn from their bases and internal components and wiring destroyed by fire. Two separate items, a faulty circuit breaker and the cleaning fluid used in the switchboard months before, were initially blamed. However, upon further analysis, improper system design features became suspect. The upstream circuit breaker probably did not clear the fault because it did not have adequate interrupting capacity for the available fault current. The switchboard was damaged because it was not braced for the available fault currents. The common denominator was the fault current analysis. The existing components were not appropriate for the system in which they were installed. The electrical plant was, either in the original design or during subsequent modifications, most likely considered an assembly of components. These components may have been acceptable if used within their design limitations, but were not adequate when used in a system with high available fault currents.

The systems approach usually begins with an analysis of the "one-line diagram" and it's supporting information. The plan review section of this chapter, 3.B.2.b(2), contains a "typical" shipboard electrical one-line diagram and index to the applicable requirements in 46 CFR Subchapter J, the National Electrical Code, IEEE-45, etc.

For electrical equipment on ships, it is not the intent of the regulations to require a separate class of "marine electrical equipment." The intent is to permit normal, off-the-shelf commercial and industrial equipment to the maximum extent practicable, with additional "marine" requirements only when needed. The acceptance of this type of equipment is made possible by careful consideration of equipment application, location and placement. Subchapter J contains general requirements for electrical equipment to ensure that passengers, crew, and other persons, and the vessel are protected from electrical hazards. It also ensures that equipment necessary under both normal and emergency conditions is located in a manner that allows for routine maintenance and testing, thus helping to ensure that the equipment will function properly when needed.

- b. Location and Placement (46 CFR 111.01-3). Optimal equipment location should be sought. In general, electrical equipment should be located in as dry a location as practicable and electronic equipment located in a controlled environment. In evaluating location, both normal and abnormal conditions should be considered. Abnormal conditions include items such as piping leaks (overhead for lower pressures and "in the vicinity" for higher pressures). For more critical equipment, such as the main switchboard, the regulations provide specific construction and location details. Generally, equipment should be located where it would not be subjected to oil, vapors, steam or dripping liquids. However, where relocation is not practicable, or where additional safeguards are warranted, the equipment should be designed to withstand these influences. Equipment should also be located to minimize the risks to personnel when routine service is being performed.
- c. Degrees of Enclosure (46 CFR 111.01-9). Where exposed to the weather, or in a space exposed to seas, washdowns, or similar

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- 3.G.2 c. (cont'd) moisture, equipment must be in a watertight enclosure (NEMA 4 or 4X or IEC IP56). A watertight enclosure is one that does not leak when subjected to a specified hose or immersion test. Motors must be waterproof. Waterproof motors may experience some leakage when subjected to the hose test, however, the leakage must not hinder operation, or enter any oil reservoir, and provision must be made for automatic draining before the level becomes damaging. Where dripping liquids could fall on equipment, that equipment enclosure should be dripproof. Dripproof equipment is ordinarily designed to prevent falling drops of liquid or solid particles from interfering with the operation of the equipment when striking the enclosure downward at any angle from 0 to 15 degrees from the vertical. Some equipment is designed for angles up to 45 degrees. It should be verified during vessel inspection that electrical equipment is suitably located - away from damaging liquid (unless impracticable, in which case it must be suitably designed), and accessible for inspection, adjustment and testing.
- d. Corrosion (46 CFR 111.01-11). The corrosiveness of the marine environment is well known, and protection can usually be accommodated at the design stage. Much of the equipment that finds its way to sea was originally intended for a commercial or industrial installation on land, and could quickly fail in a salt-water environment if additional precautions are not taken. For this reason, equipment located in the weather, or in other locations subjected to salt water, must be evaluated to ensure corrosion resistance. Not only must the enclosure be corrosion-resistant, but current-carrying components and internal parts whose failure would create an unsafe condition must also be corrosion-resistant.
- e. Porcelain (46 CFR 111.01-13). Porcelain should not be used for lamp sockets, switches, etc. unless resiliently mounted. The concern is that rigidly mounted porcelain may fail under shipboard vibration and create a shock, fire or other hazard to the vessel and its personnel. Some off-the-shelf equipment, designed for typical land installations, only comes with rigidly mounted porcelain insulated components. In these instances, it may be necessary to add resilient mounts to the porcelain insulating material. Only in instances where porcelain failure would not create a hazard, or where there is data available to support a shipboard application, such as vibration and shock (impact) testing, should such rigid installations be evaluated for general safety equivalency.
- f. Temperature (46 CFR 111.01-15). The present regulations assume an ambient temperature of 40 degrees Celsius (104° F), except for engine rooms, boiler rooms, and auxiliary spaces, which are assumed to be 50 degrees (122° F) (unless shown or designed to be less, in which case 40 degrees Celsius is assumed). There are, however, differences in national and international standards on assumed values of ambient temperatures. IEEE-45 allows for both 45 and 50 degree ambient temperatures for engine rooms, and allows switchboard apparatus (other than molded case circuit breakers) rated for 40 degrees to be used in 50 degree environments under some conditions (see Section 17.6 of IEEE-45). The American Bureau of Shipping's Rules assume a 45-degree ambient for engine rooms, but indicate that rotating machinery is to be rated for a 50 degree ambient. ABS is in agreement with the requirements in the IEC standards. In looking at the